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ABSTRACT

This guide for writing research or technical reports discusses eleven basic elements of such reports and provides examples of "good" and "bad" wordings. These elements are the title, problem statement, purpose statement, need statement, hypothesis, assumptions, procedures, limitations, terminology, conclusion and recommendations. This guide is intended especially for use by educators entering research activities in the field or by teachers, professors, and students involved in a course in technical or research writing. (Author/JH)

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ELEMENTS OF A RESEARCH REPORT

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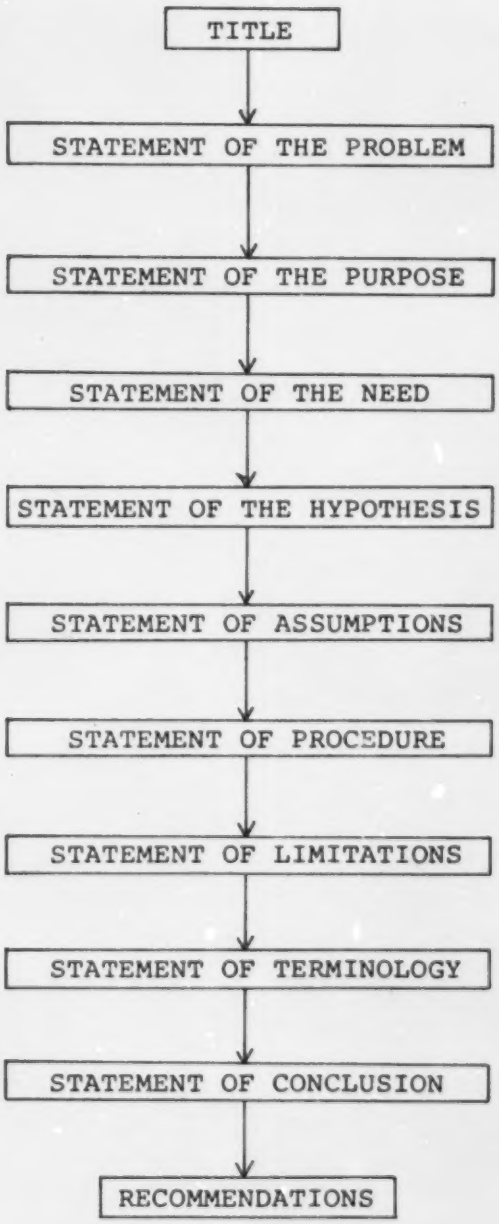
PREFACE

Writing a research report often represents a difficult hurdle for the Research and Experimentation student. This need not be the case, however. The techniques for the communication of research information have developed to the point where there is substantial agreement upon certain conventions and reporting styles. The process is almost routine. The organization of the information, the basic outline of the report, even specific phrasing within each section of the report has become, more or less, standardized. Research reports include certain elements that are generally accepted and employed. The majority of differences one does encounter can be seen as minor variations once these basic elements have been recognized and understood.

This paper discussed eleven basic elements of a research report that were enumerated in the syllabus for Dr. Donald Maley's course in "Research and Experimentation in Industrial Arts." The sequence of presentation of the elements conforms to their normal order of appearance in an actual research report. Figure 1 depicts this sequence graphically. The interpretations contained herein owe much to the thoughtful criticisms given both by Dr. Maley and the EDIN 415 class of the Fall, 1977.

Figure 1

Elements of a Research Report



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Section 1

TITLE

The title of a research report is a label that is used to refer to the report. The locating of desired reports in files and reference listings is possible because of the use of titles. The title tells the reader what topics have been discussed in the report.

Characteristics of a Good Title

- CONCISE

  The title should be brief. The maximum length should be 12-15 words.

  Examples:

  (Bad) "An analysis of ..."

  "A study of ..."

  These phrases are superfluous since it can be assumed that all research reports are comprised of "an analysis" or "study" of certain data.

  (Good) "An experimental comparison of ..."

  Here, the exact nature of the design of the research is clearly and concisely stated.

- DESCRIPTIVE

  The title should convey the exact topics of the report. The report's major variables or theoretical issues should be listed.

Examples:

(Bad) "An experimental comparison of the strength of various glue joints."

(Good) "An experimental comparison of the sheer strength of selected oak wood glue joints."

- COMPREHENSIVE

The title sets limits for the report; it tells what will and what will not be studied.

Examples:

(Bad) "An experimental comparison of the effect of solar insolation on photo cells."

(Good) "An experimental comparison of the current outputs of selected thicknesses of silicon photo cells under constant solar flux."

- USEFUL

The title gets the report into the hands of those who want the information. Included in the title should be the terms or phrases that a researcher would think to look under when searching through an index.

A tentative title, written at the outset of the study, will keep the researcher focused on the major topics under investigation. The title is the report's most succinct condensation. The final formulation of the title should, therefore, wait until the report is completed and the writer can identify exactly the topics of the report. A final title should communicate to the potential reader what has been investigated in the study.

Section 2

STATEMENT OF THE PROBLEM

The statement of the problem tells the reader what specific questions are addressed in the study. It answers the question: "What is the research trying to accomplish?" The statement of the problem re-states the title in the opening text of the report and guides the development of the investigation.

Characteristics of a Good Statement of the Problem

- DESCRIBES THE STUDY

  The statement of the problem accurately states the topics under investigation. Clarity in the statement of the problem can facilitate the research effort.

  Examples:

  (Bad) "This study was conducted in order to solve the problem stated in the title."

  (Good) "The problem of this study was to experimentally compare the power outputs of selected propellers of different diameters under specified wind tunnel conditions."

- ESTABLISHES CONDITIONS

  The major limits of the study are set by the statement of the problem. The focus of the research effort is maintained through the clarification of these broad limits.

Examples:

(Bad) "The problem of this study was to try to measure the power output of various four cylinder engines."

(Good) "The problem of this study was to experimentally compare the nutritional value of selected vitamin enrichment compounds before and after their being baked at 450 degrees Fahrenheit for one hour.

- IDENTIFIES OBJECTIVES

The specific intent of the research effort is made explicit. Clearly stated objectives can become yardsticks against which the results of the research will be measured.

Examples:

(Bad) "A study to show ..."

"After months of reviewing the literature, the researcher could see ..."

"What other problem could have been more obvious ..."

The "voice of experience" or rhetorical comments should be avoided.

(Good) "The problem of this study was to develop suggestions for reporting research in the Industrial Education Department at the University of Maryland."

- NAMES THE VARIABLES

The statement of the problem identifies those factors of the total problem that have been isolated, manipulated, or compared. The research design depends on the careful treatment of these variables.

The statement of the problem, accurately drawn, expresses the fundamental intent of the study. It is expressed well when the statement of the problem communicates: 1.) the focus of the study, 2.) the conditions under which the investigation was conducted, 3.) the explicit intent of the report, and 4.) the variables or theoretical issues of concern in the investigation.

Section 3

STATEMENT OF THE PURPOSE

The broad range of possible subjects has been narrowed by the researcher into a manageable study. The statement of the purpose reveals the researcher's purposes in selecting this particular focus over any other.

Characteristics of a Good Statement of the Purpose

- EXPLICIT

  The statement of the purpose makes clear the usefulness of the report as envisioned by the researcher. More precise interpretations of the report are possible when the researcher's thoughts on its applicability are known.

  Examples:

  (Bad) "I did this study because ..."

  Always avoid personal pronouns in writing a research report.

  (Good) "The purpose of this study was to provide information concerning the relationship between salt water corrosion and selected protective boat finishes in order that an effective consumer choice could be made."

- SYSTEMATIC

  The statement of purpose expresses the rationale for ordering the subordinate questions entailed in the main topic.

The statement of purpose expresses the researcher's personal intentions in conducting the experiment. Properly written, the purposes will help insure that appropriate criticism will be accorded the research effort.

Section 4

STATEMENT OF THE NEED

The researcher has expressed a personal reason for conducting the experiment under the Statement of the Purpose. It is necessary, as well, to establish a rationale for the study which is based on professional concerns in the area of research being considered. Expert opinions, expressions of societal needs and summaries of literature surveys provide the context in which a research report is evaluated and used. The statement of the need should clearly and concisely explain this context.

Characteristics of a Good Statement of the Need

- ESTABLISHES IMPORTANCE

  The need statement anticipates the question, "So what?" that might, otherwise, come at the conclusion of the research report.

- STRIKES A CONFIDENT ATTITUDE

  The temptation to be apologetic about the study should be avoided.

  Examples:

  (Bad) "It seemed as if it might be possible to attempt to answer the question ..."

  (Good) "The need for the study was based on the following factors:
  1. ..... (etc.)"

- MAINTAINS MODESTY

  The statement of the need should stay clear of the idea that the research has provided a panacea within the field of study.

Recommendations for further study that are part of concluding remarks in other research in the field are often good sources for documentation of the need for the study. The researcher's thorough understanding of the field under investigation is reflected in the need statement. An objective, rational and well documented statement of need allows for constructive and relevant criticism to be made about the research effort.

Section 5

STATEMENT OF THE HYPOTHESIS

To hypothesize is to formulate one's opinions concerning a specific situation so as to suggest a relationship between a set of observed facts and a theoretical explanation of the facts. A hypothesis, in other words, is stated in such a way as to clearly establish the grounds upon which the hypothetical statements can be supported or refuted. The statement of the hypothesis provides the theoretical structure for the testing of the research data.

Characteristics of a Good Statement of the Hypothesis

- DIRECTS DATA GATHERING

  The hypothesis of the study indicates the kind of data required for the experiment.

- LIMITS THE SCOPE OF THE INVESTIGATION

  The hypothesis of the study helps avoid the confusion of too much data to interpret.

- UNIFIES THE RESEARCH DESIGN

  The actual structure of the research is suggested by the nature of the hypotheses.

  Examples:

  (Bad) "The hypothesis of this study was that it would work."

(Good) "It was hypothesized that there would be no significant differences in the force required to sheer the selected oak wood glue joints."

The use of the "null" hypothesis (as in the previous example) makes more direct the application of Fisher's* statistical methods for testing the significance of a given relationship. But, no matter in what form the hypothesis is expressed, it opens the research to experimental criteria of evaluation. The manner in which the independent variable is manipulated and the relationships between measured variables and theoretical constructs are established through careful formulation of the hypotheses. A hypothesis expresses an opinion and outlines a research plan for the verification of that opinion.

*See: Fisher, R.A. The Design of Experiments, Edinburgh and London, 4th edition, 1945, Oliver and Boyd, Ltd.

Section 6

STATEMENT OF ASSUMPTIONS

Certain theoretical relationships, certain "laws of nature," and certain facts pertaining to the research effort must be taken for granted. Not all variables can be controlled in an experiment. Assumptions concerning the nature of these relationships need to be made explicit. The statement of assumptions makes clear what relationships have been taken as "given" for the purposes of the study.

Characteristics of a Good Statement of Assumptions

- SYSTEMATICALLY DEVELOPED

  The listing of assumptions needs to be clear, concise, and complete.

- CONSISTENT WITH HYPOTHESES

  Assumptions must correspond with the hypotheses of the study so that one does not "assume" the results of the study to be true. Tautologies are to be avoided.

  Examples:

  (Bad) "It was observed that the temperature changed, but this was not part of the experiment."

  (Good) "It was assumed that ..."

  "The following assumptions were made in pursuit of this study:

1. Changes in operating temperature did not effect the gauge readings.
2. ..... (etc.)"

The statement of assumptions provides the researcher with "legal loopholes" from which to rescue the study from blanket criticisms. The ability to generalize and make useful the research for others in the field is directly related to the design of the research and the resulting list of assumptions necessary in order to bring the study into its broadest possible relevancy. If the assumptions of the study are acceptable to the critic, then the criticism must deal with the internal logic and validity of the research, itself.

Section 7

STATEMENT OF LIMITATIONS

The statement of limitations acknowledges those factors involved in the research that tend to reduce its reliability. The extent to which one would want to put complete trust in a given experiment should be measured against the reasonableness of the limitations. The researcher is well advised to be explicit and demanding concerning the listing of limitations in the research.

Characteristics of a Good Statement of Limitations

- NUMBER OF CASES NOTED

  The statement of limitations should always consider the reliability of the study in terms of the number of instances upon which generalizations are being made.

- SAMPLING ERRORS NOTED

  The restriction of the investigation to any subgroup of a population needs careful explication.

- OTHER CONSTRAINTS

  The duration of the study, the physical conditions of the research environment, the accuracy of the measurement apparatus, and the data analysis techniques might all form limitations for a research effort.

Examples:

(Bad) "The limitations of the study were:
1. It was limited to 19 trials.
2. The machine limited ..."

Here, the phrasing is redundant.

(Good) "The following limitations were inherent in the study:
1. Nineteen trials were conducted in each test position...(etc.)"

The statement of limitations reflects the degree to which the researcher was able to look at the study as a detached observer and recognize factors which tended to restrict the reliability or general applicability (validity) of the findings. It is characteristic of the scientific enterprise that the researcher states these limitations rather than waiting for his critics to notice them.

Section 8

STATEMENT OF PROCEDURE

The statement of procedure, as presented in the first chapter of a thesis or research report, provides a brief overview of the study. Each stage of the investigation is noted, but in each stage precise details concerning the actual activities undertaken are kept to a minimum. The intent is to provide an overview of the manner in which the study was approached, designed, conducted, recorded, analyzed and reported.

Characteristics of a Good Statement of Procedure

- OUTLINES THE RESEARCH REPORT

  The statement of procedure facilitates the efficient use of the research report through summarizing and depicting general features of the investigation.

- SCHEMATICALLY DEPICTED

  The use of a schematic display of the stages of investigation is highly recommended. (See Fig. 2.)

- COMPLETE SENTENCES

  The statement of procedure may be a series of enumerated activities, but each should be written as a complete sentence.

Examples:

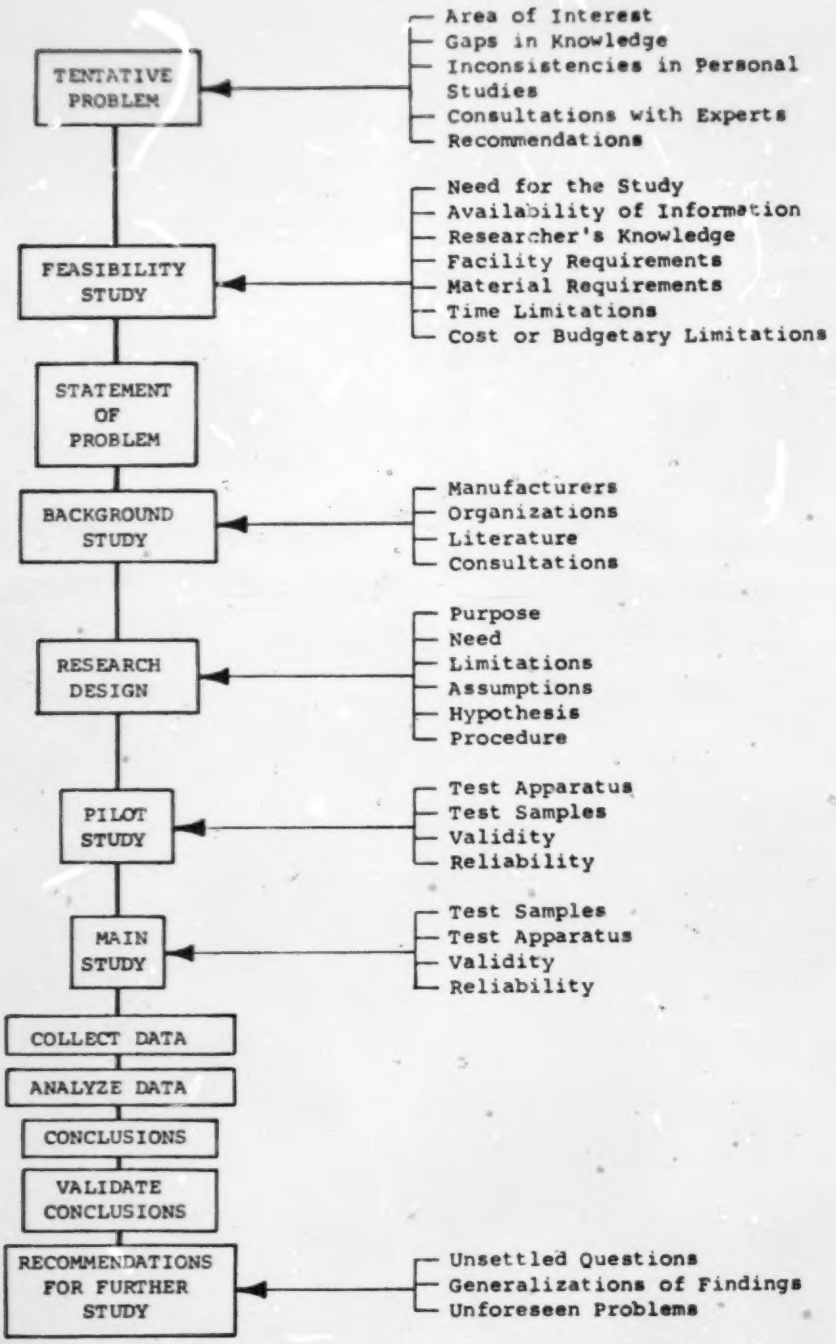
(Bad) "First the topic was picked, then the literature was consulted, then the design was selected ..."

(Good) "The procedure for this study was as follows:
1. .....
2. ..... (etc.)"

The statement of procedure is an honest, straightforward portrayal of the actual stages through which the researcher worked from the initial selection of an area of investigation to the final recommendations and concluding remarks. The purpose of the procedural schematic is to allow rapid comprehension of the study in its broad design. The statement of procedure assists the reader in locating details of the research report that are of immediate use.

FIGURE 2

Procedural Schematic*



* This procedural schematic was taken from Dolim, "Guidelines for the Development of Schematics for Research." (See Reference.)

Section 9

STATEMENT OF TERMINOLOGY

The statement of terminology provides clear definitions of terms used in the study which would, otherwise, be ambiguous. Not all terms, in other words, need defining.

Characteristics of a Good Statement of Terminology

- OPERATIONAL DEFINITIONS

  Terms are defined within the context of the particular study being reported. They should have clearly stated operational definitions.

  Examples:

  (Bad) "Power is the ability to act or produce an effect ..."

  (Good) "Power, in the course of this study, was defined in terms of the volume of water pumped into the receiving vessel in one minute."

- EXCLUDES COMMON USAGE TERMS

  A term that is in common useage in a particular field of research need not be defined under the statement of terminology.

Operational definitions must be given to terms which have been used in special cases within the study. These

definitions need to be consistent with the statement of hypothesis and the assumptions and limitations of the research report. *Special usage of terms should be kept to* a minimum.

Section 10

STATEMENT OF CONCLUSION

Conclusions provide a concise statement of the outcomes of the investigation. Often, the conclusions are read by persons who have not read more than the title, the statement of the problem and the hypothesis of the report. The conclusion should be written with this in mind.

Characteristics of a Good Statement of Conclusion

- NON-TECHNICAL LANGUAGE

  The findings should be translated into ordinary language as much as possible.

- RELATED DIRECTLY TO THE HYPOTHESIS

  The conclusions must be drawn strictly in terms of the hypotheses stated at the beginning of the report. No additional factors need be introduced at this point.

- ANSWERS QUESTIONS RAISED IN THE STUDY

  The conclusion should not leave questions brought up during the study unanswered. It is stylistically proper to bring all threads of the report to as complete a statement as possible.

  Examples:

  (Bad) "In conclusion it seems appropriate to discuss the potential sheer strength of wood joints constructed in pine ..."

(Good) "It was concluded that the null hypothesis was supported (or refuted) by the data growing out of this study."

The conclusions need to be written carefully. It is not the case that conclusions are a part of the report where the researcher is allowed to indulge his fantasies or literary aplomb. Indeed, the conclusions must be stated only in the terms used in the statement of the hypotheses.

Section 11

RECOMMENDATIONS

The final statements of the report should present the researcher's recommendations as to the conduct of further research in the field, the application of the findings of the report, and/or suggestions for changes in methodology of study in the field. Recommendations should be rooted in the findings of the study. Speculation about distantly related issues is inappropriate.

Characteristics of Good Recommendations

- GERMANE TO THE STUDY

  Recommendations need to be based on the actual subject matter that was investigated.

  Examples:

  (Bad) "Someone should study the strengths of glue joints using different kinds of materials and using different kinds of glues."

  (Good) "The following recommendations were made as a result of this study:
  1. .....
  2. ..... (etc.)"

- PROFESSIONALLY GUIDED

  Recommendations should reflect the researcher's desire to further the study of the subject matter in the most constructive manner.

Examples:

(Bad) "It is obvious that Brand 'X' paint should be used for boats."

(Good) "The following recommendations were made as a result of this study:

1. It was recommended that a wider range of products be tested.
2. It was recommended that the effect of varying salt concentrations in sea water be determined.
3. ... (etc.)

Recommendations should be made cautiously. They should extend only slightly beyond the bounds of the research report, itself. Many ideas for further study listed at the end of the report would only serve to distract the reader from his own thoughts on the matter. Keep in mind that others may use the recommendations as documentation of the need for further research in the field.

AFTERWORD

The elements of research that have been discussed in the preceeding sections combine to form the final report. It should be understood that the presentation is only suggestive and was not intended to provide inflexible rules for the writing of the research report. There is a rule, however, that is quite rigorously enforced in the presentation of research information; namely, write in the past tense. Since, at the time of final writing, the investigation has been completed; it is expected that all references to the study will be in the past tense.

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